REMARKS

By this amendment claims 1, 3, 8, 9, and 12, have been amended. Claims 1-16 remain pending. Reconsideration of the application as amended is respectfully requested.

A marked-up version of the claims show the changes made is submitted in Appendix I.

Rejections under 35 USC §112

Claim 9 has been rejected under 35 USC §112 as failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention. The Examiner has stated that "a layer of silicon nitride" does not provide antecedent basis for "said silicon nitride layer."

It is respectfully submitted that there is no other element in the claim to which "said silicon nitride layer" could possibly refer than to the element "a layer of silicon nitride." It is not understood how the phrases "silicon nitride layer" and "layer of silicon nitride" have any meaningful difference. One of ordinary skill in the art would not be confused as to whether the phrase "said silicon nitride layer" refers back to "a layer of nitride layer" or possibly one of the other elements of the claim such as the "semiconductor wafer assembly," the "layer of silicon dioxide," or the "etch chamber." The meaning of the phrase is not unclear and the scope of the claim is easily ascertainable by those skilled in the art, and it is therefore submitted that the claim is not indefinite, for example under the requirements of MPEP §2173.05(e). The Examiner's requirement is therefore respectfully traversed. If the Examiner can provide a reasonable explanation of how the phrase "said silicon nitride layer" is unclear, confusing, or could be mistaken with one of the other terms in the claim by one of ordinary skill in the art, the applicant will entertain amendment of the claim as suggested by the Examiner.

The Examiner has also stated that "a layer of silicon dioxide" does not provide antecedent basis for "said silicon dioxide layer." This rejection is respectfully traversed as being unreasonable for reasons stated relative to the rejection of "a layer of silicon nitride" and "said silicon nitride layer."

Rejections under 35 USC §102

Claim 1, 8, 9, and 11 have been rejected under 35 USC §102(b) as being anticipated by Mao et al. (US 5,877,073). Mao recites providing a patterned photoresist layer then using 20 sccm CHF_3, 50 sccm O_2, and 320 sccm argon to etch silicon nitride, polysilicon, and silicon dioxide. This is performed at a preferred chamber pressure of about 400 millitorr and a power of about 525 watts (column 3 line 50-column 4 line 2).

The present invention as claimed recites novel and nonobvious differences over the recitation of Mao. Claims 1, 8, and 9 as filed, for example, recite the use of an etch "consisting essentially of oxygen...and one of CHF_3 and CH_2F_2." Each of these claims further recites a chamber "pressure of between about 10 millitorr and about 60 millitorr."

The Examiner states that since "argon is an inert gas [it] does not materially affect the basis and novel characteristics of the etching process." This statement is respectfully traversed. Although argon is inert and not a chemical etchant, it can clearly provide a mechanical component to the etch. It is respectfully submitted that using the Examiner's rationale, sand, since it is chemically inert, could not be used effectively for sandblasting. US Patent 5,580,821 has been cited as support to demonstrate that argon is a known etchant, and describes an etch using argon as the sole etchant at column 3 lines 51-56. The fact that Mao introduces argon at a flow rate which is more than six times the flow rate of the next highest gas demonstrates that the argon has some effect on the properties of the etch of Mao. The language of present claims 1, 8, and 9 "consisting essentially of oxygen...and one of CHF_3 and CH_2F_2" is novel and nonobvious over Mao. This language, which is found in rejected claims 1, 8, and 9 as filed, removes Mao as a reference under 35 USC §102.

Mao recites the use of a photoresist layer during etching, and etching at high pressure of about 400 millitorr (column 3 line 50-column 4 line 2). This is clearly different from claims 1, 8, and 9 as amended, which recite etching "in the absence of a photoresist layer" and at "a pressure of between about 10 millitorr and about 60 millitorr." Etching in the presence or absence of a photoresist layer is likely to produce different results, as resist is known to contribute carbonaceous molecules which interact with etchants or chemical byproducts and alter etch characteristics.

Further, the fact that the etch of Mao removes silicon nitride, polysilicon, and silicon dioxide (column 3 lines 57-60) demonstrates the etch is different from the present invention which removes silicon nitride selective to polysilicon and silicon dioxide (see page 3 paragraph 9, for example).

For at least the above-stated reasons the present invention as recited in rejected claims 1, 8, and 9, and claim 11 which depends from claim 9, are novel, nonobvious, and allowable under 35 USC §102 over Mao et al.

Claim 1 has been rejected under 35 USC §102(b) over Bosch et al. (US 5,625,716). Bosch comprises the use of 10-20 sccm CHF_3 and 70-110 sccm O_2 at a power of 100-200 Watts and a pressure of 100-200 millitorr to etch silicon nitride selective to TEOS. Bosch removes the silicon nitride which is exposed by an opening 12A in a mask 12 which patterns the wafer surface (column 5 line 66-column 6 line 12).

Claim 1 as amended recites novel and nonobvious differences over the method of Bosch. For example, claim 1 recites "etching said silicon nitride layer in the absence of a photoresist layer...and...during said etching, subjecting said silicon nitride layer to a pressure of between about 10 millitorr and about 60 millitorr." Bosch teaches away from the absence of a photoresist layer by using a mask 12 during the etch of the silicon nitride 15 and further etches the silicon nitride at a higher chamber pressure, in the range of 100-200 millitorr, than is instantly claimed. As the pressure increases, the selectivity to SiO_2 and to silicon decreases (see page 3 paragraph 11), thus the claimed pressure imparts criticality to present claim 1. Thus claim 1 is allowable over Bosch et al.

Claim 8 has been rejected over each of Lou (US 5,872,045) and Klein (US 6,046,088) under 35 USC §102(b). Each reference recites the use of a gas mixture such as CHF_3 and O_2 to etch Si_3N_4 (see each reference, column 4 lines 52-55). Lou and Klein each further recites using a photoresist layer to pattern the underlying silicon nitride layer, and omit specifying any pressure range.

Claim 8 recites etching silicon nitride "in the absence of a photoresist layer...at a pressure of between about 10 millitorr and about 60 millitorr." Both Lou and Klein teach away from etching in the absence of a resist layer by teaching the formation of a resist layer. Etching in the presence or absence of a photoresist layer is likely to produce different results, as resist is known to contribute carbonaceous molecules which interact with etchants or chemical byproducts and alter etch characteristics. Further, the specified pressure range imparts criticality because as the pressure increases, the selectivity to SiO_2 and to silicon decreases (see page 3 paragraph 11). Thus claim 8 is allowable over each of Lou and Klein under 35 USC §102(b).

Rejections under 35 USC §103

Claims 2-7, 10, 12-16 have been rejected under 35 USC §103 as being unpatentable over Mao. Mao recites providing a patterned photoresist layer then using 20 sccm CHF_3, 50 sccm O_2, and 320 sccm argon to etch silicon nitride, polysilicon, and silicon dioxide. This is performed at a preferred chamber pressure of about 400 millitorr and a power of about 525 watts (column 3 line 50-column 4 line 2).

As discussed relative to the rejection of claims over Mao under 35 USC §102, argon clearly affects the properties of the etch of Mao. The language of claims 1 and 9 from which the rejected claims depend recite an etch "consisting essentially of oxygen...and one of CHF_3 and CH_2F_2", and thus the use of any measure of argon which affects the characteristics of the etch is excluded. Further, claims 1 and 9 from which the rejected claims depend recite etching silicon nitride in the absence of a photoresist layer, while Mao recites the use of a photoresist layer. As it has been demonstrated that the cited reference does not teach every feature of the invention as claimed, the rejection over Mao is improper under 35 USC §103, and the rejected claims are allowable (see MPEP §706.02j).

Moreover, the Examiner states that "it would have been obvious to one having ordinary skill in the art, at the time of invention, to modify Mao by perform routine experiment to obtain optimal flow rate ratio, flow rate of CHF_3 and O_2, pressure, power as an expected result." However, it is submitted that the parameters stated by the Examiner as yielding expected results in fact have interactions that often provide unexpected results. For example Bosch et al., cited by the Examiner, states that "[w]hile elaborate theories have been developed to explain the plasma etching process, in practice most such processes have been developed largely by experimentation involving trial and error because of the relatively poor predictability of result otherwise" (column 1 lines 63-67). Thus the results that the Examiner states are "expected" are described by Bosch et al. as having "poor predictability."

Thus claims 2-7, 10, and 12-16 are allowable over Mao at least because they depend from an allowable base claim and because the reference does not teach every feature of the invention as claimed.

Claims 2-7 have been rejected under 35 USC §103 over Bosch et al. Bosch comprises the use of 10-20 sccm CHF_3 and 70-110 sccm O_2 at a power of 100-200 Watts and a pressure of 100-200 millitorr to etch silicon nitride selective to TEOS. Bosch removes the silicon nitride which is exposed by an opening 12A in a mask 12 which patterns the wafer surface (column 5 line 66-column 6 line 12).

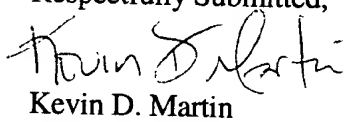
Claim 1 from which claims 2-7 depend recites novel and nonobvious differences over the method of Bosch. For example, claim 1 recites "etching said silicon nitride layer in the absence of a photoresist layer...and...during said etching, subjecting said silicon nitride layer to a pressure of between about 10 millitorr and about 60 millitorr." Bosch teaches away from the absence of a photoresist layer by using a mask 12 during the etch of the silicon nitride 15 and further etches the silicon nitride at a higher chamber pressure, in the range of 100-200 millitorr, than is instantly claimed. As the pressure increases, the selectivity to SiO_2 and to silicon decreases (see page 3 paragraph 11), and the claimed pressure imparts criticality to present claim 1. Thus claims 2-7 are allowable over Bosch et al. at least because they depend from an allowable base claim and because the reference does not teach every feature of the invention as claimed which is necessary for proper rejection under 35 USC §103 (MPEP §706.02j)

The Examiner states that "it would have been obvious to one having ordinary skill in the art, at the time of invention, to modify Bosch by perform routine experiment to obtain optimal flow rate ratio, flow rate of CHF_3 and O_2, pressure, power as an expected result." Again, the parameters stated by the Examiner as yielding expected results in fact have interactions that often provide unexpected results. Bosch itself states that "[w]hile elaborate theories have been developed to explain the plasma etching process, in practice most such processes have been developed largely by experimentation involving trial and error because of the relatively poor predictability of result otherwise" (column 1 lines 63-67). Thus the results that the Examiner states are "expected" are described by Bosch et al. as having "poor predictability." Thus it is submitted that the rejected claims are allowable over Bosch et al. under 35 USC §103.

Conclusion

All of the pending claims are believed to be in condition for allowance. If the Examiner believes a conference would expedite prosecution of the case, the Examiner is cordially invited to call the undersigned. This is believed to be a complete and proper response to the Examiner's outstanding office action.

Respectfully Submitted,



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APPENDIX I
VERSION WITH MARKINGS TO SHOW CHANGES MADE

In the Claims

1. (amended) A method for etching a layer of silicon nitride comprising:

etching said silicon nitride layer in the absence of a photoresist layer with an etchant consisting essentially of oxygen at a flow rate of between about 20 sccm and about 80 sccm and one of CHF_3 and CH_2F_2 at a flow rate of between about 5 sccm and about 25 sccm; and

during said etching, subjecting said silicon nitride layer to a pressure of between about 10 millitorr and about 60 millitorr.

3. (amended) The method of claim 1 further comprising subjecting said silicon nitride layer to [a pressure of between about 10 millitorr and 60 millitorr and] a power of between about 300 watts and about 600 watts during said etching.

8. (amended) A method used during the formation of a semiconductor device comprising:

providing a semiconductor wafer assembly comprising at least one of a layer of silicon and a layer of silicon dioxide;

forming a layer of silicon nitride over said at least one of said layer of silicon and said layer of silicon dioxide;

etching said silicon nitride in the absence of a photoresist layer with an etch consisting essentially of oxygen and one of CHF_3 and CH_2F_2 and a pressure of between about 10 millitorr

and about 60 millitorr, wherein said etch exposes said at least one of said layer of silicon and said layer of silicon dioxide.

9. (amended) A method used during the formation of a semiconductor device comprising:

providing a semiconductor wafer assembly comprising a silicon wafer and a layer of silicon dioxide overlying said wafer;

forming a layer of silicon nitride over said silicon wafer and over said layer of silicon dioxide;

placing said semiconductor wafer assembly into an etch chamber;

etching said silicon nitride layer in the absence of a photoresist layer using an etch consisting essentially of oxygen and one of CHF_3 and CH_2F_2 and a pressure of between about 10 millitorr and about 60 millitorr to expose said silicon dioxide layer and said silicon wafer.

12. (amended) The method of claim 11 further comprising subjecting said silicon nitride layer to [a pressure of between about 10 millitorr and 60 millitorr and] a power of between about 300 watts and about 600 watts during said etching.